Distributed Energy Neural Network Integration System (DENNIS™)

Presented by: Thomas M. Regan

Orion Engineering Corporation

Westford, MA

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Distributed Power System Integration Research and Development
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NREL Technical Monitor: Holly Thomas
Research Team Members

Principal Investigator: Thomas Regan
Orion Engineering Corp. Westford, MA

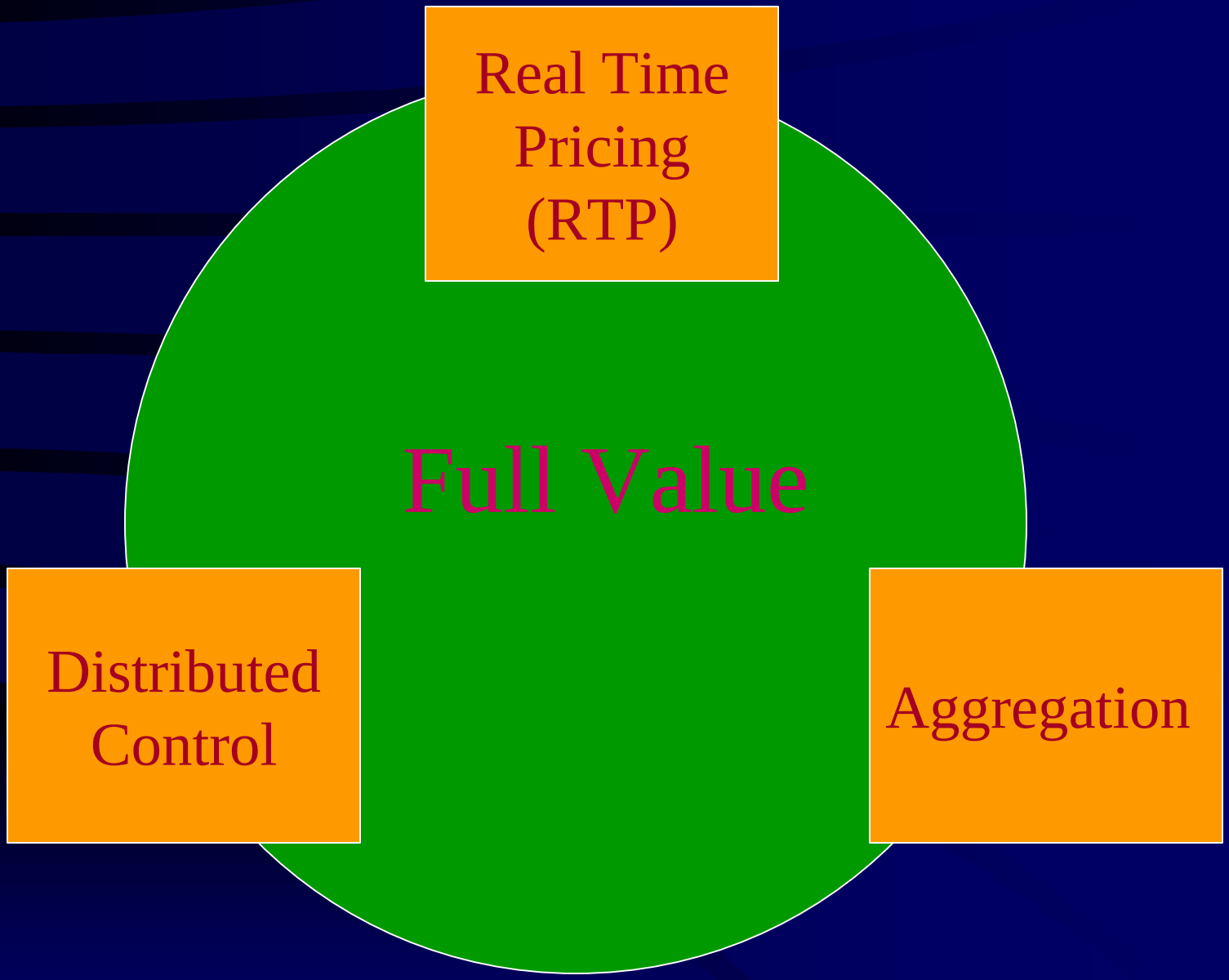
Sub-tier Principal Investigator: Dr. Ziyad Salameh
University of Massachusetts Lowell, Lowell, MA

Project Objectives

- Develop “next generation” of distributed energy control and integration technology that will enable deployment and coordination of Distributed Power (DP) technologies.
- Empower DER owners through autonomous, intelligent and distributed “command and control logic” that will carry out system decision making ensuring efficient, economical, yet safe and reliable dispatch of distributed energy systems.

OEC Distributed Power Project

- Planned 3-year project to develop a controller for small DG
- Demonstrate the ability for a group of controllers to operate through a neural network.
  - Provide technologically sophisticated and simple solution
  - Aggregates a community of small DG into a virtual generator capable of selling power in a coordinated manner.
- Result - energy integration product for residential, commercial and industrial DG applications.


Real Time Pricing (RTP)
Full Value
Distributed Control
Aggregation

OEC Solution: DENNIS™

- Uses neural networks and fuzzy logic to determine the best method(s) to maximize the benefits to the generator, rather than the central utility.
- Monitors weather, load, demand, market price and generation capacity.
- Capable of optimizing to a single **user** or to a larger group of **users**.
- Enables cost-effective, remote dispatch and coordination of aggregated DER.

DENNIS™ manages generation dispatch, not load!

Year 1 Project Goals

- Perform facilities upgrades and modifications at the University of Massachusetts Lowell (UML) Center for Energy Conversion (CEC).
- Design, build and test major subcomponents of DENNIS™.
- Develop an economic model/analysis of the potential impact of our method for aggregating and managing distributed power.
- Establish industrial contacts and relationships to allow effective product to transfer into residential and business sectors.

University Collaboration

- UML CEC - Characterization
  - CEC test facilities include 3 wind turbines, PV, and lead/acid battery storage.
  - Facility upgrades: New 750 W_e of PEM fuel cell, electronic upgrades to power switching and computer inverter control system.
- Boston University (BU) Cognitive and Neural Systems (CNS)
  - Neural network technical advisory

UML CEC Facilities

Storage and inverter systems

UML CEC Facility

750 W_e PEM FUEL CELLS

Subcomponent Development

- Created database of training and test data for weather and energy prices
- Developed complete algorithms for optimization and neural learning
- Programming and testing in progress

Economic Model

Home with 7kWh/day Excess Photovoltaic Generation:

- DENNIS saves $3.35/day over standard service
- DENNIS saves $1.24/day over net metering

Home with 7kWh/day Excess Hydrocarbon Generation:

- DENNIS saves $2.06/day over standard service
- DENNIS saves $3.79/day over net metering
  - Net metering costs an additional $0.24/day

Market Development

- Formed Zero-Net Energy Alliance of Lowell (Z_nEAL).
- Licensing Beta version of DENNIS™ for application of DG coordination and control.
- Forming new corporate entity with mission to deploy DENNIS™ based technologies.
- Formed Technical Advisory Board
- Participating in IEEE P1547 working group
- Forming alliances with local small businesses to support renewable technology development and deployment.

Conclusions

- Infrastructure investments and upgrades completed.
- Command, Control and Coordination algorithms designed, and are in the process of being coded and tested.
- Tested and evaluated DENNIS^{TM} subcomponents utilizing the facilities at the University of Massachusetts Lowell CEC.
- Developed an economic model/analysis of the potential impact of our method for aggregating and managing distributed power that provide increased ROI over conventional energy delivery schemes.
- Established industrial contacts and relationships seeking to transfer product to commercial and residential markets.